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A Device-Based, Time-Compressed Strategy for Army National Guard Tank Gunnery Training

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This report describes a training strategy to reduce or compress the time needed to prepare for tank crew qualification on Table VIII through use of the Conduct-of-Fire Trainer (COFT) and Guard Unit Armory Device Full-Crew Interactive Simulation Trainer, Armor (GUARDFIST I). To compress time, the authors recommend that training (a) be focused on only those gunnery skills needed for Table VIII qualification, (b) be given only to crews with demonstrated performance deficiency, and (c) be devoted to those Table VIII engagements found to be most difficult. The strategy is designed specifically for use by armor units of the U.S. Army National Guard.

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FOREWORD

The Army National Guard (ARNG) is seeking to place greater emphasis on the use of training devices to enhance homestation M1/M1A1 tank gunnery training. To help ensure the success of this approach, ARNG armor unit trainers need "how to" guidance on the use of specific devices to maximize training effectiveness and efficiency. This report provides such guidance in the form of a device-based training strategy for reducing or compressing the time required to prepare ARNG tank crews for live-fire Table VIII qualification.

This research was conducted by the U.S. Army Research Institute for the Behavioral and Social Sciences Reserve Component (RC) Training Research Unit, whose mission is to improve the effectiveness and efficiency of RC training through use of the latest in training technology. The research task supporting this mission, "Train Up: Technology-Based RC Training Strategies," is organized under Science and Technology Objective V.B.7, Unit Training Strategies.

The National Guard Bureau (NGB) sponsored this research under a Memorandum of Understanding signed 12 June 1985. Results have been presented to Chief, Training Division, NGB; Chief, Training Division, Office of the Chief, Army Reserve; and Special Assistant to the Commanding General, U.S. Army Armor Center.

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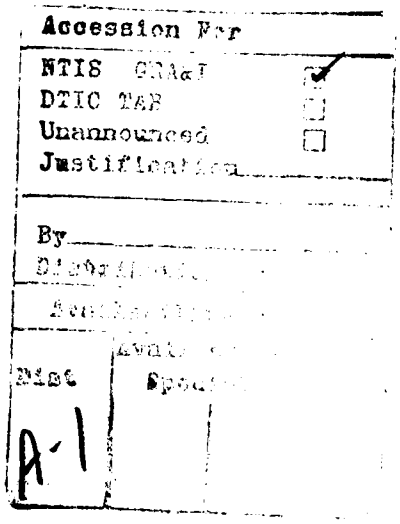

A DEVICE-BASED, TIME-COMPRESSED STRATEGY FOR ARMY NATIONAL GUARD TANK GUNNERY TRAINING

EXECUTIVE SUMMARY

Requirement:

To develop a device-based training strategy that reduces or compresses the time required to prepare U.S. Army National Guard (ARNG) tank crews for live-fire Table VIII qualification.

Procedure:

The strategy was developed by answering the following questions:

1. What are the performance requirements of Table VIII?
2. What are the capabilities of existing computer-based devices to support training on those requirements?
3. What training methods should be used to facilitate (a) the acquisition of gunnery skills on the devices, and (b) the transfer of these skills to performance on Table VIII?

Findings:

1. The performance requirements of Table VIII can be summarized by eight unique engagements.
2. Two devices are capable of providing training on these eight engagements: the Conduct-of-Fire Trainer (COFT) and the Guard Unit Armory Device Full-Crew Interactive Simulation Trainer, Armor (GUARDFIST I).
3. To promote acquisition and transfer, and yet compress training time, the authors recommend that training be focused on only those gunnery skills needed for Table VIII qualification, be given only to crews with a demon-strated performance deficiency, and emphasize the most difficult of the eight unique Table VIII engagements.

Utilization of Findings:

The training strategy is designed specifically for use by ARNG armor units. The rationale supporting its development, however, could be applied to other situations where the type and availability of operational equipment and training devices differ.

A DEVICE-BASED, TIME-COMPRESSED STRATEGY FOR ARMY NATIONAL GUARD TANK GUNNERY TRAINING

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A DEVICE-BASED, TIME-COMPRESSED STRATEGY FOR ARMY NATIONAL GUARD TANK GUNNERY TRAINING

Introduction

Military Problem

Armor units of the U.S. Army National Guard (ARNG) face three severe constraints that negatively impact tank gunnery training. First, ARNG armor units are severely limited in the time that can be devoted to gunnery training. Second, these units are restricted in their access to and in their use of gunnery range/maneuver areas. Third, the costs of tank-based live-fire training are increasingly prohibitive, both in terms of ammunition and operating tempo (CPTEMPO) expenses. To meet the challenges of training in this resource-constrained environment, the ARNG is committed to incorporating computer-based devices into its gunnery training program. To maximize the payoff from this approach, a detailed strategy is needed to guide the design and execution of device-based gunnery training at the unit (i.e., company) level.

The present training strategy provides detailed guidance on how to prepare tank crews specifically for Intermediate Gunnery Qualification on Table VIII. Table VIII is a live-fire gunnery performance test that measures a crew's ability to engage and hit realistic targets presented at realistic ranges (Department of the Army [DA], 1993). The purpose of the proposed training strategy is to reduce or compress the time required to prepare for Table VIII through the systematic use of computer-based devices.

Background

A "training strategy" may be defined as the systematic configuration of instructional content and/or methods intended to enhance training effectiveness and efficiency. Several different approaches have been used to develop training strategies for tank gunnery. These approaches are summarized and evaluated below with respect to the following requirements of the present strategy: the strategy must be (a) device-based, (b) time-compressed, and (c) focused on Table VIII performance.

The Combined Arms Training Strategy (CATS) was developed in 1992 by Headquarters, Training and Doctrine Command (HQ TRADOC). The CATS document describes an "over-arching" strategy that describes how training should be conducted in the Force Projection Army. Specifically, the CATS document explains how the training strategy interfaces with the related processes of training development, budget management, requirements determination, and materiel acquisition. The CATS document provides a tank gunnery training strategy as an example of many such strategies that could be developed from CATS. The example strategy specifies some detailed training information, such as the progression and frequency of use of specific training resources for individual skills training through platoon- and

company-level exercises. Whereas the example is meant to be realistic, the document cautions that different mixes of resources may also lead to the same desired objective (i.e., the unit being trained to standard). Therefore, commanders are not required to adhere strictly to CATS guidance.

Based on CATS, the U.S. Army Armor School (USAARMS, 1993) devised a more detailed and prescriptive gunnery training strategy that was tailored to the unique time and resource constraints of the Reserve Component (RC). This strategy is particularly relevant in that it describes how specific training resources should be used to prepare for Table VIII. Although this strategy emphasizes the use of on-tank training to accomplish its goals, it does specify how one training device, the Conduct-of-Fire Trainer (COFT), should be used to train for Table VIII. An important restriction of the RC strategy is that COFT not be used during regular gunnery training periods, which are reserved for hands-on training with the tank. Instead, COFT should be used "...after normal training (daylight hours) ends and during selected concurrent training periods" (p. 13-3). Furthermore, training on COFT is dispersed over the training year. Thus, although the RC training strategy provides detailed guidance for training Table VIII skills, it is neither time-compressed nor device-based.

In contrast to the RC training strategy that emphasizes on-tank training, the micro-strategy for ARNG units developed by Morrison, Campshure, and Doyle (1991) emphasized the use of devices to achieve gunnery proficiency. This device-based strategy was derived from a hierarchy of training objectives as prescribed by the Tank Combat Tables, FM 17-12-1 (DA, 1990). From this hierarchy, Morrison et al. (1991) described a three-phase strategy wherein crews (a) start preliminary gunnery training at the armory, (b) progress to basic gunnery training at a local training site, and (c) continue to intermediate gunnery that culminates in the live-fire Table VIII exercise. In their year-long strategy, units move beyond the intermediate phase, which is devoted exclusively to gunnery, to the advanced phase, which is more concerned with tactics in preparation for collective training exercises. Thus, although the Morrison et al. (1991) strategy is device-based, it is neither time-compressed nor focused solely on Table VIII.

Recently, Leonard (1993) devised a 5-day rapid train-up package for preparing crews to qualify on Table VIII. This strategy implicitly recognizes that individual skills should be learned before crew interactions. Day 1 of the strategy is devoted to instruction and evaluation on fundamental individual and crew gunnery skills, many of which are identified on the Tank Crew Gunnery Skills Test (TCGST). Day 2 is devoted to intensive training on each of the four crew stations on the M1 tank and a dry-fire crew exercise that emulates Table VIII conditions and targets. Days 3 and 4 are reserved for live-fire training on Tables V and VII, respectively. Table VIII is fired on Day 5. In addition to on-tank exercises, crews are assigned COFT training in 2-hr blocks on each of the 4 days prior to Table

VIII. During that time, the crews are expected to complete 15 different COFT exercises. The exercises appear to be generally ordered in difficulty; however, Leonard did not provide a rationale for selecting the exercises. Also, it is not clear whether the 5 days are to be distributed across different inactive duty training (IDT) weekends or concentrated in a single 5-day block of time within a longer training period, such as Annual Training (AT). More detail is needed to specify how this strategy would be implemented in ARNG units.

Research Objectives

The purpose of the present research is to develop a tank gunnery training strategy that uses training devices to prepare ARNG crews for Table VIII. A principle requirement for this device-based strategy is that it be time-compressed so that it can be implemented in no more than 3 IDT periods. By "time-compressed" we mean that the strategy has the following three characteristics:

1. The skills and knowledges trained by the strategy are limited only to those needed for successful Table VIII performance. This implies that preparation for other gunnery evaluation events (e.g., Tables IX-XII or the Tactical Tables) requires additional training that is not included in the present strategy.

2. The content of instruction is focused on those unique Table VIII engagements that are most problematic for ARNG crews. In other words, training time is not devoted to training engagements on which crews are likely to be proficient.

3. Device training time is allocated to crews that need it most. Valuable training time is not expended on crews that are already fully proficient on the devices or that quickly acquire proficiency after a short period of training.

Organization of Report

The remainder of this report is divided into three sections, each of which addresses basic questions about the compressed training strategy. In order, these questions may be stated as follows:

1. What are the performance requirements of Table VIII?

2. What are the capabilities of existing computer-based devices to support training on those requirements?

3. What training methods should be used to facilitate (a) the acquisition of gunnery skills on the devices, and (b) the transfer of these skills to performance on Table VIII?

Table VIII Performance Requirements

Table VIII consists of 12 tank gunnery engagements (see Table 1) divided equally into two groups of 6 engagements each: Table VIIIA, is conducted during daylight hours, whereas Table VIIIB is conducted at night. Two engagements (A5S and B1S) are designated as "swing" engagements that may be fired under day or night conditions in accordance with seasonal variations in the number of daylight hours. Also, one day and one night engagement are designated as "alternates" to be used if the range cannot support specific conditions: Alternate engagement A5A is used if the range does not have the two moving targets required by engagement A5; B5A is used if the range cannot provide the external illumination required by B5 due to ammunition or safety restrictions. In practice, this means that an individual crew fires only 10 of the 12 engagements specified by Table VIII.

To promote transfer of training from a training device to Table VIII performance, device-based training objectives should correspond closely to actual engagements in Table VIII. However, practicing all 12 engagements on Table VIII may be unnecessary. Our approach was to define training objectives based on a reduced subset of critical Table VIII engagements. Two methods were used to reduce the number of engagements for training. First, the behavioral requirements of the engagements were examined to identify duplication and to combine engagements accordingly. The goal was to define a subset of distinctively different engagements that provide a comprehensive array of Table VIII tasks and conditions. Second, objectives were ranked on difficulty of performance. Data on the difficulty of engagements were provided by Hagman (1994) who examined the first-round performance of three ARNG units that underwent Table VIII qualifications on fully instrumented ranges in 1993. Hagman (1994) argued that gunnery training should emphasize the more difficult engagements to affect the greatest increase in Table VIII performance in the shortest time.

Combining Similar Engagements

Four offensive engagements (A4, A5S, A5A, and B4) are similar in that they require the crew to engage either one or two tank targets from a moving tank using precision gunnery. Hagman's (in publication) analysis of Table VIII performance data indicated that crews generally perform better on single-target than on two-target engagements. Presumably, the greater difficulty of two targets is due to the additional requirement to determine the relative danger of targets and to engage them in the appropriate sequence. To ensure that this additional requirement is practiced, the training objective should be defined for the more difficult (i.e., two-target) condition. Target movement, on the other hand, is not a factor when the firing tank is on the move, because the gunner is required to track stationary as well as moving targets. Thus, the combined training objective corresponding to all four engagements may be stated as follows: "On the offense, engage stationary or moving tanks with the main gun using precision gunnery."

Table 1

Description of Table VIII Engagements

Engagement	Description
	Table VIIIA (Day)
A1	On the defense, engage a moving and a stationary tank with the main gun using the gunner's auxiliary sight (GAS) and battlesight gunnery techniques.
A2	On the defense, simultaneously engage a stationary BMP (tracked armored personnel carrier or APC) with the main gun and a stationary BTR (wheeled APC) with the tank commander's (TC's) Caliber .50 machine gun.
A3	On the offense, engage two sets of troops with the coax machine gun using precision gunnery techniques.
A4	On the offense and under nuclear, biological, and chemical (NBC) protection status, engage two stationary tanks with the main gun using precision gunnery techniques.
A5A	On the offense, engage a stationary and a moving tank with the main gun using precision gunnery.
A5S	On the offense, engage two moving tanks with the main gun using precision gunnery techniques.
	Table VIIIB (Night)
B1S	On the defense, engage a stationary tank with the main gun with a three-man crew using precision gunnery techniques.
B2	On the defense, engage two stationary BMPs with the main gun using precision gunnery.
B3	On the offense and under NBC conditions, engage a stationary BMP with the main gun and a stationary rocket-propelled grenade (RPG) team with the coax machine gun using precision gunnery techniques.
B4	On the offense, engage a stationary and a moving tank with the main gun using precision gunnery techniques.
B5	On the defense and under external illumination, engage a stationary tank with the main gun using the GAS and battlesight gunnery techniques.
B5A	On the defense, engage a moving tank with the main gun using precision gunnery.

Two defensive engagements (A1 and B5) are also similar in that both require the gunner to use the gunner's auxiliary sight (GAS) in response to fire control system failures that render the gunner's primary sight (GPS) ineffective. A key difference between these two engagements is that the single target in B5 is stationary whereas one of the two targets in A1 is moving. The moving target requires the gunner to apply manual lead. Since the advent of automatic lead in tank fire control systems, gunners have not trained as often on this skill. Performance on Table VIII indicates that A1 is indeed one of the most difficult engagements in Table VIII (Hagman, 1994). To train the critical tracking skills in A1, the training objective must include a moving target. Thus, a single training objective may be defined for these two engagements as follows: "On the defense, engage a stationary and a moving tank target with the main gun using battlesight gunnery and the GAS."

Sorting Engagements by Difficulty

The remaining six engagements in Table VIII present unique conditions to crews and/or require them to perform unique tasks. With the two combined engagements described above, there are eight unique engagements that incorporate the critical tasks and conditions defined by Table VIII. The eight unique engagements can be sorted into three categories according to difficulty and priority of training, as summarized in Table 2 and described below.

Most difficult engagements. The first category comprises the four engagements that Hagman (1994) identified as consistently the most problematic for ARNG units. Note that three of the four engagements (A2, A3, and B3) involve machine guns, either the coax machine gun or the TC's Caliber .50 machine gun, which evidently present a particular source of difficulty for tank crews (Hagman, 1994). The fourth difficult engagement (A1) requires the crew to engage a moving target with the GAS as discussed above. Besides being difficult to perform, these engagements also encompass most of the tasks and conditions encountered in Table VIII except those related to (a) the three-man engagement, and (b) actions related to reloading ammunition in the defense. Because these engagements are both difficult and comprehensive, they are the most important training objectives for the compressed training strategy.

Fundamental engagements. The next two engagements identified in Table 2 are labeled "fundamental" in that they require crews to engage tank targets on the offense or on the defense without significant complicating conditions. Performance data from Table VIII (Hagman, 1994) indicate that these engagements are performed relatively well, presumably because they are not complicated by "additional" requirements such as using multiple weapon systems or engaging non-tank targets. Although crews are required to perform basic gunnery skills in the difficult engagements, it is assumed that less proficient crews would acquire these skills more efficiently under the simpler conditions of the fundamental engagements.

Table 2

Three Types of Unique Gunnery Engagements and Their Correspondence to Table VIII Engagements

Type of Engagement Descriptive Title	Table VIII Engagements
Most Difficult Engagements	
On the defense, engage simultaneous targets with the main gun and TC's Caliber .50 machine gun.	A2
On the offense, engage two sets of troops with the coax machine gun.	A3
On the offense and under NBC conditions, engage a stationary BMP with the main gun and troops with the coax machine gun.	B3
On the defense, engage a stationary and a moving tank target with the main gun using battlesight gunnery techniques and the GAS.	A1 & B5
Fundamental Engagements	
On the offense, engage stationary or moving tanks with the main gun using precision gunnery techniques.	A4, A5S, A5A,& B4
On the defense, engage a moving tank with the main gun using precision gunnery techniques.	B5A
Special Engagements	
On the defense, engage two stationary BMPs with the main gun using precision gunnery techniques.	B2
On the defense, engage a stationary tank target with a three-man crew using precision gunnery techniques.	B1S

Special engagements. The defining characteristics of the remaining two engagements are that they are behaviorally more complex than the fundamental engagements, and yet they do not appear to be difficult to perform on Table VIII. These are labeled "special" engagements because they should be trained only under special circumstances.

1. Engaging stationery BMPs from the defense. This engagement requires the crew to interact to reload ammunition before starting the engagement. If the gun tube is already loaded with a round that is appropriate for a heavily armored vehicle (e.g., a tank), the loader must change to one that is appropriate for a lightly armored target (e.g., APC or BMP). Although this represents a complication over a fundamental engagement, Hagman's (1994) data indicate that this engagement (B2) is performed relatively well. A possible explanation for this finding is that the loader changes ammunition before starting the engagement and is therefore not scored. Because ammunition change evidently has little impact on Table VIII performance, we suggest that the engagement be trained only if the loader is inexperienced.

2. Three-man crew management. The second special engagement requires the crew to engage targets in a nonstandard configuration. Despite this nonroutine arrangement, the empirical data indicate that engagement B1S is consistently one of the best performed engagements in Table VIII (Hagman, 1994). However, good performance on this engagement may have less to do with difficulty per se and more to do with the fact that the engagement is fired by the TC, the most experienced member of the tank crew. Consequently, this engagement should be practiced only if the TC has relatively little experience as a gunner.

Device Capabilities

Two computer-based training devices, that are available to ARNG units, are appropriate for training the objectives identified in the previous section: the M1/M1A1 Conduct-of-Fire Trainer (COFT)[1] and the M1 Guard Unit Armory Device Full-Crew Interactive Simulation Trainer, Armor (GUARDFIST I). The COFT capabilities assume the latest software enhancement, as described in Instructor Utilization Handbook for the M1/M1A1 Advanced Matrix (USAARMS, 1991). GUARDFIST I capabilities are based on the first production model of GUARDFIST I to be manufactured by Industrial Data Link (IDL) and Computer Sciences Corporations (CSC) as described in GUARDFIST I Exercise Summary (IDL & CSC, 1994, February).

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[1]In this report, COFT is used to refer to both the Mobile Conduct-of-Fire Trainer (M-COFT) and the Unit Conduct-of-Fire Trainer (U-COFT). M-COFT is mounted on a semi-tractor trailer to allow it to be moved from unit to unit, whereas the U-COFT is permanently mounted at one site. Otherwise, the two versions of COFT are functionally identical.

With regard to fidelity of simulation, COFT and GUARDFIST I are roughly comparable. For instance, both COFT and GUARDFIST I allow crews to use realistic tank controls in response to realistic computer-based imagery displayed through tank optics. For the present strategy, however, there are two key differences between devices:

1. Configuration. COFT is a stand-alone simulation of the gunner and TC tank crew stations. The COFT system simulates inputs from the other two crewmen (loader and driver) when signaled by the instructor/operator (I/O). In contrast, GUARDFIST I is appended to a stationary tank in an armory setting and uses the tank's actual controls and optics. Furthermore, it provides training for all four crew positions, although the loader and driver simulation is at a lower level of fidelity than the TC and gunner simulation (Campshure, 1991).

2. TC's Caliber .50. COFT simulates all three M1 tank weapon systems (main gun, coax machine gun, and TC's Caliber .50 machine gun), whereas GUARDFIST I simulates all but the TC's Caliber .50 machine gun. As a result, GUARDFIST I does not support training on the simultaneous engagement (A2). This is particularly problematic for the present strategy because this is one of the four most difficult engagements.

The training subsystems of the two devices are also organized similarly. The lowest instructional unit is an "exercise" which is comprised of multiple engagements linked by a common combat scenario. Both devices use a prescriptive training matrix in which crews are required to demonstrate proficiency on easier exercises before being allowed to advance to more difficult ones. This feature can effectively limit access to particular exercises. If the I/O initializes the COFT advanced matrix using a secure password, however, he can override the computer recommendation and select any exercise in the advanced matrix. A similar procedure for directly accessing exercises is planned for implementation in the GUARDFIST I training matrix. The present strategy assumes that these procedures can be used by the I/O to select any of the exercises in either training matrix.

Both devices offer two types of exercises: (a) evaluation exercises that present a heterogeneous set of engagements intended to simulate Table VIII conditions and tasks, and (b) training exercises that contain a more homogeneous set of engagements that are focused on particular gunnery skills.

Evaluation Exercises

Both devices automatically score performance on the evaluation exercises using standards from FM 17-12-1-2 (DA, 1993). As shown in Table 3, the devices simulate most, but not all, of the 12 engagements in Table VIII. The implications of specific omissions are discussed below.

COFT. Table VIII evaluation exercises (termed "Gate" exercises in the advanced COFT matrix) make up the last set of

Table 3

Table VIII Engagements Simulated by COFT and GUARDFIST I Evaluation Exercises

Engagement	Device	
	COFT	GUARDFIST I
A1	X	X
A2	X	
A3	X[a]	X
A4	X	X
A5S	X[b]	X[b]
A5A		X
B1S	X[c]	X[d]
B2	X	X
B3	X	X
B4	X	X
B5	X	
B5A	X	X

Note. "X" indicates that the device simulates the engagement. [a]Targets are a BMP and an RPG team instead of a BMP and a BTR. [b]Only daytime viewing conditions are simulated. [c]Some exercises simulate daytime viewing conditions, while others simulate nighttime conditions. [d]Only night viewing conditions are simulated.

exercises in Group I of the advanced matrix. Each of the 16 Gate exercises presents a different selection and ordering of 10 engagements from Table VIII. Some exercises include engagement B5, whereas others use the alternate version (B5A). However, only one version of the fifth engagement in Table VIIIA (A5S) is represented in the Gate exercises; the alternate version (A5A) is not simulated. This is not a serious deficiency because the two engagements are very similar in their behavioral requirements; the only difference is that A5S calls for two moving tank targets whereas A5A calls for one moving and one stationary tank target.

The targets presented in A2 (the simultaneous engagement) are not identical to those presented in the current version of Table VIII (DA, 1993) because the COFT target array was derived from the previous version of Table VIII (DA, 1990). Although the COFT target array is somewhat different, the behaviors required to perform the new engagement are identical to those required to perform the old engagement. Thus, performance on the COFT

version of A2 is probably a valid predictor of performance on the newer simultaneous engagement despite the discrepancy in the target array.

GUARDFIST I. The Table VIII evaluation exercise is part of the final group of training exercises (Group 6) in the GUARDFIST I training matrix. In contrast to COFT, there is only one version of the GUARDFIST I evaluation exercise, which presents 10 of the 12 engagements in Table VIII. One of the omitted Table VIII engagements is B5, which is replaced by its alternate version (B5A). This choice was apparently required because GUARDFIST I does not simulate external illumination required in engagement B5. However, the remaining GAS engagement (A1) is clearly the more difficult of the two; therefore, the omission of B5 should not seriously reduce GUARDFIST I's ability to predict performance on GAS engagements.

The other missing engagement is the simultaneous engagement (A2), which cannot be simulated because the TC's Caliber .50 machine gun does not function. To make up for this deletion both versions of engagement A5 (A5S and A5A) are presented, which is contrary to Table VIII doctrine (DA, 1993). The omission of the simultaneous engagement deletes one of the most difficult engagements from Table VIII (Hagman, 1994). Unlike the previous omission, this one may reduce the validity of the GUARDFIST I evaluation exercise as a predictor of Table VIII performance.

Training Exercises

To describe the capability of devices to support the objectives of the strategy, training exercises were selected from COFT and GUARDFIST I training matrices that correspond to the eight unique engagements identified in the previous section. The results of the selection process are summarized in Table 4. Appendix A documents, in more detail, the relationship of the selected device exercises to the conditions of the corresponding Table VIII engagement. The method and results of the selection process are described below.

COFT. Training exercises were all selected from Group 1 of the advanced matrix, the group of exercises specifically designed to prepare crews for the Gate exercises--that is, the simulated Table VIII engagements. Selecting advanced matrix exercises was complicated by the fact that the conditions of advanced matrix exercises are only partially specified. At a minimum, exercises identify firing tank movement (moving vs. stationary); however, each exercise specifies only one additional condition from the following list: viewing condition (night), sight employed (GAS), malfunction (laser range finder [LRF] or stabilization [STAB]), or weapon used (Caliber .50 or coax). The remaining engagement conditions (most notably types and ranges of targets) are randomly determined by the COFT software.

The COFT exercises were selected such that the engagement being trained appears with some frequency. Unfortunately, other

Table 4

COFT and GUARDFIST I Training Exercises Corresponding to the Eight Unique Engagements in Table VIII

Type of Engagement Descriptive Title	Device Exercises COFT	 GUARD-FIST I
Most Difficult Engagements		
On the defense, engage simultaneous targets with the main gun and TC's Caliber .50.	101 111[b]	---[a]
On the offense, engage two sets of troops using the coax machine gun.	102 106	6A2
On the offense and under NBC conditions, engage a stationary BMP with the main gun and troops with the coax machine gun.	110	6B3
On the defense, engage a stationary and a moving tank target with the main gun using battlesight gunnery and the GAS.	113 117	6A1
Fundamental Engagements		
On the offense, engage stationary or moving tanks with the main gun using precision gunnery.	102 106 110	6A3 6A4 6A5 6B4
On the defense, engage a moving tank with the main gun using precision gunnery	105	6B5
Special Engagements		
On the defense, engage two stationary BMPs with the main gun using precision gunnery.	105	6B2
On the defense, engage a stationary tank target with a three-man crew using precision gunnery.	103 107 119	6B1

[a]GUARDFIST I does not simulate the Caliber .50 machine gun and therefore is unable to support training on this engagement. [b]COFT provides only part-task training for the TC on the Caliber .50 machine gun.

types of engagements are also likely to appear. For instance, exercises 102 (offensive-normal) and 106 (offense-night) contain both coax and main gun targets and are selected to train both types of engagements. Unfortunately, this makes the COFT more difficult to use for training particular Table VIII engagements: It requires the I/O to identify and highlight performance on the type of engagement being trained and ignore performance on the other types of engagements.

The simultaneous exercises are particularly difficult to use for training. To practice simultaneous engagements using exercise 101 (defense-normal), the crew must wait for two targets that appear simultaneously and that pose approximately the same level of danger to the firing tank. Furthermore, at least one target must be vulnerable to Caliber .50 machine gun fire. If these conditions are not met, the targets should be engaged sequentially. The other exercise indicated for this engagement (111, defense-Cal .50) provides only part-task training on this engagement--that is, practice for the TC on using the Caliber .50 without the main gun.

GUARDFIST I. The document entitled GUARDFIST I Exercise Summary (IDL & CSC, 1994, February) identifies specific exercises in Group 6 that are specifically designed to train individual Table VIII engagements. Each of the exercises in Table 4 consists of 3-5 engagements, presented in random order. One of the engagements in these exercises closely mirrors the corresponding Table VIII engagement. The other engagements in the exercise represent variations on the basic exercise. The variations are complications such as the introduction of a system malfunction (LRF or STAB system), the imposition of NBC requirements, and/or the use of the alternate sight (GAS). As a result of these variations, crews would learn additional gunnery skills that are not necessarily relevant to Table VIII.

As in the evaluation exercises, there is no corresponding training exercise for engagements A2 (the simultaneous engagement) and B5 (the GAS engagement under external illumination). The former omission is more important because it does not permit the crew to practice one of the most difficult engagements in Table VIII. The omission of B5 appears less problematic, because the important conditions of this engagement are also represented in A1, the other GAS engagement.

Comparison of Device Capabilities

Campshure (1991) compared the capabilities of previous versions of COFT and GUARDFIST I. Comparing the present findings with Campshure's indicates that the capabilities of the two devices have become more similar, particularly in their ability to evaluate and train Table VIII skills. This is not to deny that the devices have shortcomings. For instance, COFT still cannot train drivers or loaders, and GUARDFIST I still does not provide training on the simultaneous engagement. In most other respects, however, the devices offer redundant capabilities. As a result, the training strategy, described in the next section,

can be implemented with either device. The strategy includes instruction designed to inform crew members about and compensate for specific deficiencies of the devices.

Training Methods

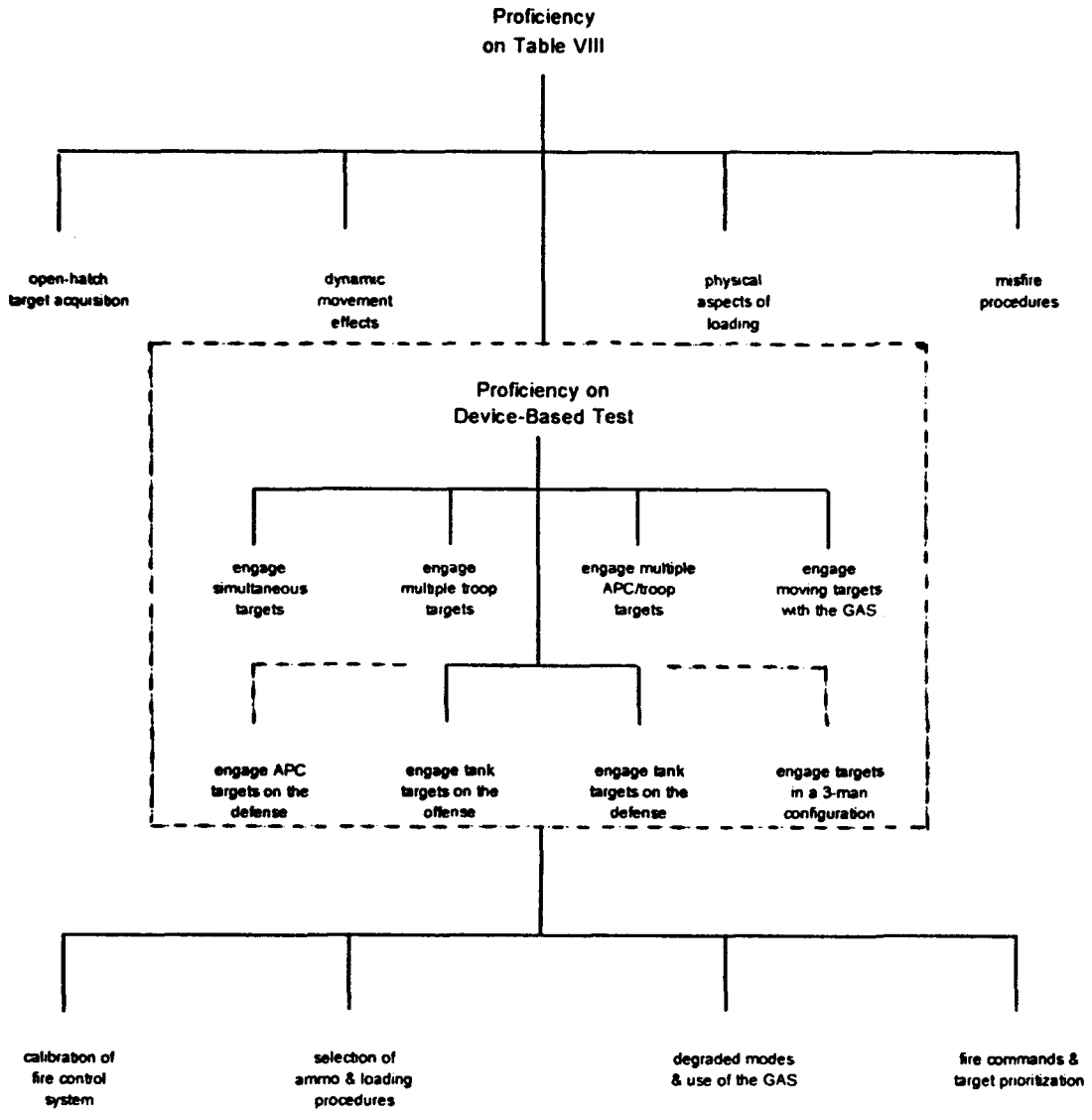
Given the training objectives and device capabilities, the final step in the development of the training strategy is to specify efficient and effective methods for training Table VIII skills and knowledges. This method includes the specification of a hierarchy of skills and knowledges trained by the strategy. The purpose of the structure is (a) to identify the types of skills and knowledges that are related to Table VIII proficiency, and (b) to organize training objectives such that learning is facilitated. The method also specifies approaches and procedures for implementing the training strategy.

Figure 1 presents a comprehensive hierarchy of skills and knowledges addressed by the present training strategy. This figure depicts the skills and knowledges trained on devices as a smaller hierarchy embedded within a larger hierarchy of skills and knowledges required for proficient performance on Table VIII. Although the present strategy focuses on the competencies learned on the device, the figure is intended to illustrate that there are skills and knowledges that lie "outside" of the embedded device-based hierarchy. As described below, the strategy uses different approaches to training these two different aspects of the hierarchy.

Device-Based Training

The traditional (bottom-up) approach to training is to start by training prerequisite skills and knowledges at the bottom of the hierarchy and to add increasingly complex and comprehensive superordinate skills until the terminal objective is attained. This traditional approach is not appropriate given that ARNG crews have only a limited amount of training time on the devices. Our alternative is a top-down approach wherein crews are started at the top of the learning hierarchy to assess their proficiency. Crews shown to be proficient on COFT are not trained further on the device, making the device available to crews that are less proficient and therefore in need of more training.

The embedded hierarchy is divided intc two levels: At the top is a comprehensive device-based test designed to simulate Table VIII conditions; the lower level comprises training exercises corresponding to the four most difficult engagements. As reflected in Figure 1, proficiency on the simulated Table VIII test can be attained, in most cases, by training on the four most difficult engagements. As described earlier, however, additional practice on the special engagements may be called for under certain circumstances. Furthermore, training on the fundamental engagements is necessary if crews are deficient in basic gunnery skills.



Terminal Objective

Transfer Skills and Knowledges

Gunnery Skills Trained on Device(s)

Prerequisite Skills and Knowledges

Figure 1. Hierarchy of skills and knowledges trained in the strategy.

Testing approach. The strategy begins with a device-based pretest. The pretest has two purposes: (a) to assess the need for further training on the device, and (b) to determine readiness for live-fire training. With regard to the latter purpose, there is a growing body of evidence that performance on the COFT is predictive of live-fire performance on the range. This finding is based on a COFT-based performance test developed by Hoffman and Witmer (1989) using an earlier (standard) version of the COFT training matrix. Performance on this COFT-based test is positively correlated with Table VIII performance (Smith & Hagman, 1992; 1994). In contrast, research has failed to demonstrate a relationship between performance on Table VIII and performance on a similarly constructed GUARDFIST I performance test (Smith & Hagman, 1993b). Since that research was conducted, both devices have been improved and are better able to simulate Table VIII conditions and scoring. In particular, the production version of GUARDFIST I is better able to simulate coax machine gun engagements, which are implicated as being an important element of difficulty in Table VIII (Hagman, 1994). These improvements to both devices should only increase the ability of the device-based tests to predict Table VIII performance.

Research on Hoffman and Witmer's (1989) COFT-based test has also provided information on the appropriate length of the pretest. Their test consists of four COFT exercises, each of which simulates 10 gunnery engagements. Smith and Hagman (1992) examined the correlations between Table VIII performance and individual COFT exercises. The results showed that all four exercises were correlated more highly with Table VIII than were any individual exercise or any combination of two or three exercises. Smith and Hagman (1992) concluded that the COFT-based test should be based on no fewer than four exercises, which require approximately 1 hr to administer. Generalizing from these findings, we recommend that the device-based test should also include four separate administrations of a simulated Table VIII exercise.

The content and administration of the pretest would differ for the two devices. Starting with GUARDFIST I, the pretest should be based on evaluation exercises 6E1 and 6E2, which correspond to parts A and B of Table VIII. These two exercises should be administered four times each. The COFT matrix has 16 different versions of the Table VIII test from which to choose. To ensure that crews receive experience with as many Table VIII conditions on COFT as possible, two of the four replications of Table VIII should be drawn from each of the following two sets of Gate Exercises:

- Exercises 130-135: Alternate engagement B5A is fired in place of B5; engagement B1S is simulated under daytime conditions.
- Exercises 136-139: Primary engagement B5 is fired rather than B5A; engagement B1S is simulated under nighttime conditions.

The device-based test should have two standards of performance. The first standard is that point at which crews are deemed "qualified" for training on the tank. Some research has been devoted to determining empirical standards of proficiency, based on the relationship between performance on Table VIII and performance on Hoffman and Witmer's (1989) COFT-based test (Smith & Hagman, 1992; 1993a). However, there are no data for deriving an empirical test standard for the more recent versions of Table VIII tests on either COFT or GUARDFIST I. Until the appropriate research is conducted, a reasonable provisional standard is to require that crews score 2800 points over all four administrations. This score corresponds to an average of 700 points per administration, which is the score needed to pass an actual live-fire Table VIII.

The second performance standard is that point below which crews are deemed "untrained" in that they need training on the fundamental engagements. Again, in lieu of empirical data, a provisional definition of deficient performance is fewer than half the number of points needed to qualify or 1400 points. These standards may need to be adjusted in accordance with further research and development on device-based training.

Sequence of training. Figure 2 illustrates the sequence of training that follows the pretest. As indicated in this figure, the three types of crews can be distinguished by their pretest scores: (a) qualified (those scoring 2800 or above), (b) partially trained (those scoring less than 2800 but more than 1400), and (c) untrained (those scoring 1400 or below). These three groups and their training prescriptions are described below:

1. Qualified crews. Crews that exceed the proficiency standard may be excused from further device training. However, random errors of measurement allow the possibility of a false positive result from the pretest--that is, passing a crew that is not truly proficient. To reduce the possibility of a false positive error, all crews, including those in the following two groups, will be required to confirm proficiency by taking a device-based posttest, which is identical to the pretest. Those that pass the posttest after the pretest receive no further device training. Crews that initially pass the pretest but fail the posttest follow the training prescription for the second group. Each crew in this category spends approximately 2 hrs on the device for pre- and posttesting.

2. Partially trained crews. This category includes crews that require some device training, but are not considered fundamentally deficient in gunnery skills. If crews have a new TC or loader, they may be assigned the appropriate special engagements. At a minimum, crews are trained on the four most difficult engagements. Training proceeds on the four engagements until the crew demonstrates proficiency on the engagement, with the stipulation that training on any one engagement not exceed 1 hr. Proficiency on an engagement may be defined as destroying relevant targets (i.e., targets appropriate for the engagement

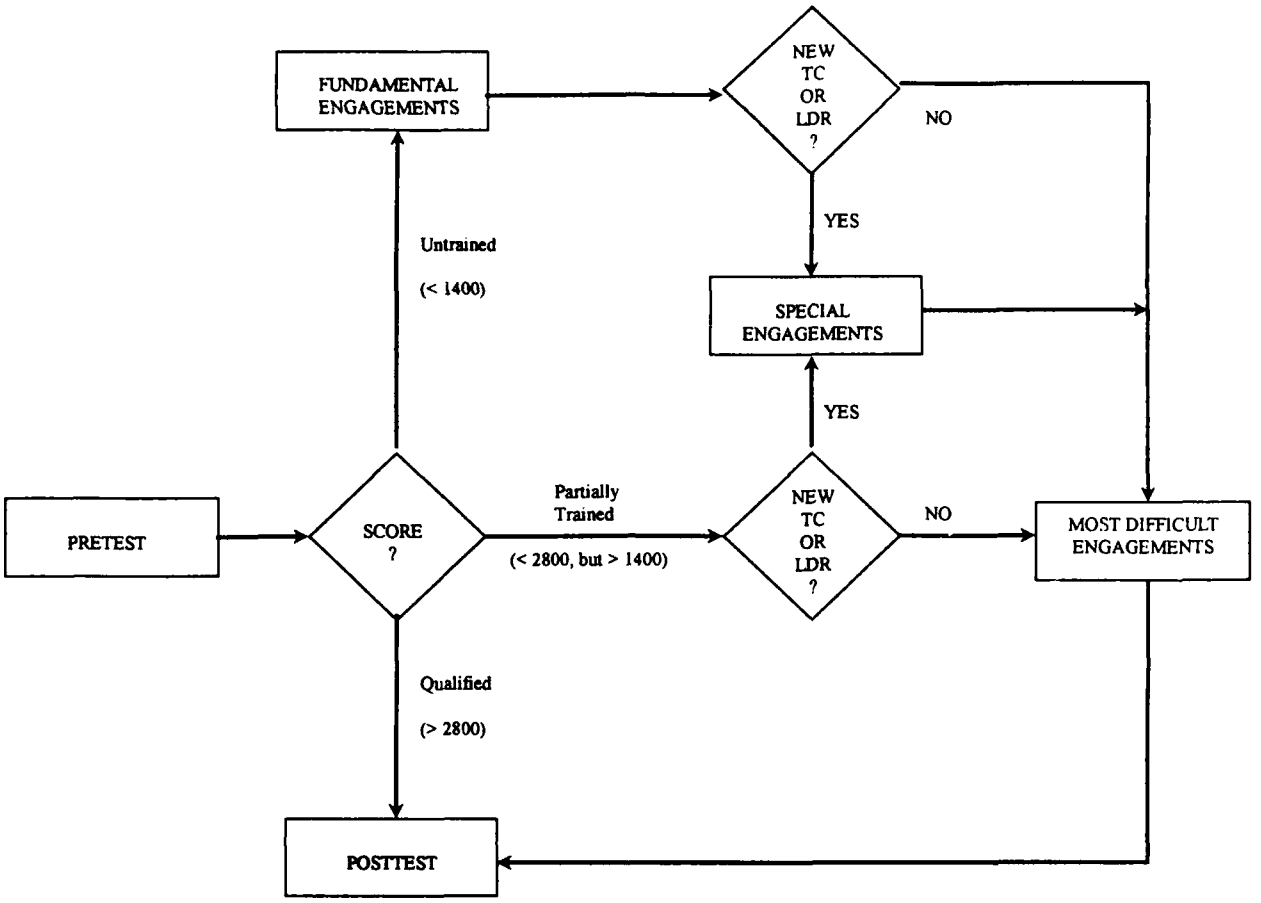


Figure 2. Flow of training and testing events in the training strategy.

being trained) on two consecutive attempts without committing a procedural error. Crews should be allowed a short (5-min) break after reaching proficiency or at the end of the hour block before going on to the next engagement. Once crews complete training on all four engagements, their proficiency is verified by a device-based posttest as described for the first group. Assuming crews do not need training on the special engagements, individual crews in this category should require no more than 6 hrs on the device, including pre- and posttesting.

3. Untrained crews. Crews that perform particularly poorly on the pretest are assigned training on the fundamental engagements. Training proceeds on these two types of engagements until crews demonstrate proficiency, but training on each engagement does not exceed 1 hr to limit this period of training to a maximum of 2 hrs. The proficiency standard is the same as that described for the difficult engagements. After completing training on the fundamental engagements, crews may receive training on special engagements as appropriate. Crews in this category are then assigned training on the difficult engagements as described above, followed by a device-based posttest. If

training on special engagements is not required, crews should not need more than 8 hrs on the training device, including both pre- and posttesting.

Instruction on Additional Skills and Knowledges

The learning hierarchy in Figure 1 distinguishes between prerequisite and transfer skills and knowledges. These two types of competencies are discussed below.

Prerequisite skills and knowledges. At the bottom of the learning hierarchy shown in Figure 1 are the fundamental competencies that crews must possess prior to the start of device-based training, some of which are described as follows:

1. Calibration of the fire control system. Crews must know how to prepare their tanks to ensure that they fire accurately. GUARDFIST I does not provide any training on muzzle boresighting and armament accuracy checks. COFT provides some practice on these procedures, but some initial knowledge of boresighting is required to begin device training.

2. Selection of ammunition and loading procedures. Prior to device training, the TC, gunner, and loader must have some basic knowledge of the ammunition that is appropriate for Table VIII gunnery. This topic includes the following two related issues:

- Loading battlecarry ammunition. The TC, gunner, and loader should know that, unless otherwise instructed, crews preload sabot (i.e., assume a battlecarry sabot posture) with the battlesight range preindexed at 1200 meters.

- Reloading HEAT ammunition. If a sabot round is preloaded but lightly armored targets (e.g., BMPs) are acquired or are anticipated, the TC, gunner, and loader should be aware of the procedures for changing ammunition from sabot to HEAT.

3. Degraded modes and use of the GAS. The TC and gunner need to know that two engagements in Table VIII are fired under degraded conditions. The degraded conditions in those two engagements are different: In the daytime engagement (A1), the computer and LRF have failed, making a precision engagement impossible; in the nighttime illuminated engagement (B5), the TIS has failed, rendering the daylight channel ineffective. Despite these differences, the course of action is the same: use the GAS. Instruction should focus on manually applying lead while tracking moving targets, an apparent source of difficulty in Table VIII performance.

4. Fire commands and target prioritization. A 5-point penalty on Table VIII scores is deducted each time crews issue an incorrect fire command or respond incorrectly to a fire command. Therefore, the TC and gunner should be well practiced on the fire commands for the precision, battlesight, and simultaneous engagements in Table VIII. In particular, the TC and gunner need

to know how to indicate which targets should be engaged first in the two-target arrays of Table VIII. They should also know the procedure for engaging the second target. These procedures require knowledge of target priorities and subsequent fire commands.

Transfer skills and knowledges. Above the embedded hierarchy in Figure 1 are skills and knowledges that aid transfer of skills learned on training devices to performance on the tank. As described below, these pertain to skills and knowledges that are not well trained by COFT and GUARDFIST I.

1. Target acquisition from the protected-open hatch position. In most Table VIII engagements, the TC and loader are allowed to search for targets from the protected-open position using magnification binoculars if desired.[2] In this position, the hatches are partially open, which provides a larger field of view than is available from the tank optics. At the same time, the protected-open position provides some protection from suppressive small-arms fire, air burst artillery, or near misses from enemy direct fire. Both COFT and GUARDFIST I are only able to simulate the view from the tank's optics. Thus, they are not able to provide practice in acquiring targets from the protected-open hatch position.

2. Dynamic movement effects. Table VIII requires all four crewmen, especially the loader, to be skilled in coping with the dynamic effects of tank movement and gun recoil. The devices do not simulate these dynamic effects and therefore do not adequately train the appropriate safety skills and procedures.

3. Physical aspects of loading. GUARDFIST I allows the loader to practice removing the round from ready racks and inserting it in the gun tube by simple button pushes. GUARDFIST I also allows the loader to use the safety guards as they would in the actual tank. However, neither GUARDFIST I nor COFT allows the loader to practice the physical aspects of handling heavy main gun rounds safely. Furthermore, the physical aspects of loading are complicated by tank movement, which is also not simulated by either device.

4. Misfire procedures. Neither COFT nor GUARDFIST I provides the opportunity to practice misfire procedures for the main gun. It should be noted that the crew is not penalized by the simple occurrence of a misfire during Table VIII: Timing is halted from the point when the crew announces "misfire" for the second time to the point when the round is fired. However, failure to perform misfire procedures correctly may be construed as a safety violation, resulting in a 10-point crew penalty.

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[2]The exceptions are the engagements A4 and B3 for M1 and M1A1 tanks and engagements A2 and B2 for M1A1 tanks only. These engagements are conducted under NBC conditions and therefore require crews to acquire targets with all hatches closed.

Furthermore, Table VIII evaluators may immediately disqualify a crew as unsafe if they are unable to perform misfire procedures.

5. Simultaneous engagements. GUARDFIST I does not have the capability to train simultaneous engagements. Furthermore, COFT training on the simultaneous engagement is difficult to implement. Thus, neither device provides adequate training on this critical Table VIII engagement.

Instructional approach. Of the individual skills identified above, some can only be acquired through normal hands-on training on the tank. Some of these experiences can be provided at the armory, provided an operational tank is available. Training in individual gunnery skills culminates in the Tank Crew Gunnery Skills Test (TCGST), which is required to be administered prior to any live-fire exercise (DA, 1993). In addition, ARNG crews normally receive field training in dry-fire gunnery exercises on the tank, such as the Tank Crew Proficiency Course [TCPC]) or the live-fire exercises leading to Table VIII (Tables V, VI, and VII). The present approach is intended to supplement, not supplant, these hands-on experiences with additional knowledge instruction.

Additional instruction is provided by a knowledge workbook designed to be completed by every armor crewman in the unit (Pope, 1994). This workbook is divided into three sections. The first section introduces the ARNG crewman to the objectives of the workbook as well as the objectives of the training strategy as a whole. The second section provides the essential knowledges required to start device-based training. The third and final section alerts the armor crewman to the differences between the device(s) and the tank, and emphasizes those aspects of live-fire training that are not well trained on devices. The introduction should be read and completed prior to device training. The remaining sections of the workbook can be completed while crewmen are waiting for training on one of the devices. The crewmen should review the final section of the workbook prior to prior to live-fire exercises.

Implementation Considerations

The strategy is designed to be implemented in 3 IDT periods. It is assumed that these periods are scheduled immediately prior to the AT period in which gunnery qualification is scheduled to occur. To minimize the impact that the strategy has on the limited time available for training, device pretesting should be combined with the TCGST. The device-based pretest would be one of the TCGST stations, requiring about 1 hr of testing per crew.

Between the TCGST and the next IDT period, the company commander and his training noncommissioned officer (NCO) should review pretest performance to determine the appropriate exercises for each crew. Depending on pretest performance, when training starts crews may be scheduled for evaluation on the posttest, training on the most difficult exercises, or training on the fundamental exercises. Similarly, performance must be reviewed

between the first and second and between the second and third IDT periods. This review is important for two reasons: (a) to select exercises that are appropriate for each crew's skill level, and (b) to determine which crews no longer require training. The latter point is important because the limited time available on the devices should be diverted to crews that need it most.

If a unit has access to both COFT and GUARDFIST I, both devices should be used to maximize crew time on devices. With both devices available, training should be scheduled such that crews practice the engagements on the device that provides the better simulation. For instance, the COFT is the better alternative for practicing the simultaneous engagement, because it provides a simulation of the Caliber .50 machine gun. Likewise, GUARDFIST I is the preferred alternative for engaging APCs because it allows the loader to practice reloading main gun ammunition.

It is more likely that only one or the other device will be available to the unit. If so, the amount of training time that an individual crew can spend on the device will be extremely limited. Suppose that a single device were available for a total of 24 hrs during a single IDT weekend. If a unit (i.e., company) has a full complement of 14 tank crews, then, an individual crew would have, on average, just over 5 hrs of training time on the device--not quite enough time for a partially trained crew to complete the strategy. Hopefully, not every crew will require this much training; nevertheless, this limitation emphasizes the need to identify proficient crews through pretesting and to eliminate their demand on device time. Also, partially trained crews must be processed as fast as possible.

Even with two devices in operation, some crews will have periods of time when they do not have access to the devices. During those times, the crews should study the workbook and train on the aspects of gunnery that are not well covered by the devices--particularly, loading and driving. Loading can be practiced in the armory using a static tank, whereas limited practice on driving can be conducted close to the armory.

The company commander and his training NCO should also consider what to do with proficient crews that do not require device training or that finish the strategy early. There are at least two activities that should be considered. The first is to start training on loading and driving. This is a high-priority activity because it continues their preparation for Table VIII. Another possibility for these crews is to act as peer tutors for slower crews that require additional attention. Both of these activities fulfill two key functions: They prevent qualified crews from being idle, and they keep training focused on Table VIII.

The time-compressed strategy prescribes that COFT and GUARDFIST I be used in ways for which they were not originally intended. A formative evaluation is needed to test the validity

of this approach in an actual ARNG setting. This evaluation should focus on the following questions:

1. Are the devices capable of providing efficient and effective training on the engagements identified by the strategy?

2. Can a typical ARNG unit complete the training prescribed by the strategy in 3 IDT periods?

3. Does device training on selected engagements improve performance on Table VIII?

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